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Depression and eating styles are independently associated with dietary intake

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ABSTRACT

Depression and eating styles are two important, interrelated factors associated with dietary intake. However, it remains unclear whether depression and eating styles are independently associated with dietary intake, and whether associations between depression and dietary intake are mediated by eating styles. Therefore, the aim of the current study was to investigate the associations of, and interplay between depression and eating styles in relation to different aspects of dietary intake. Cross-sectional data from 1442 participants (healthy controls (22.7%), remitted (61.0%) and current patients (16.3%)) from the Netherlands Study of Depression and Anxiety were used. Linear regression analyses were used to determine associations of depressive disorders (DSM-IV based psychiatric interview), self-reported depressive symptoms (Inventory of Depressive Symptomatology), emotional, external and restrained eating (Dutch Eating Behavior Questionnaire) with 4 measures of dietary intake (total energy intake (kcal/d), Mediterranean diet score (MDS), intake of sweets foods (g/d), and snack/fast-food (g/d)) measured with a 238-item food frequency questionnaire. Statistical mediation analyses were used to study whether associations between depression and dietary intake were mediated by eating styles. Current depression diagnosis and severity were associated with lower MDS and higher intake of sweet foods and snack/fast-food. Emotional and external eating were associated with higher intakes of snack/fast-food; external eating was also associated with higher total energy intake. Restrained eating was associated with lower total energy and intake of sweet foods, and higher MDS. Associations between current depression or severity and intake of snack/fast-food were mediated by external eating. In general, depression and eating styles contributed independently to poorer diet quality and higher intake of sweet and snack/fast-food. The association between depression and higher intake of snack/fast-food was mediated by external eating.

1. Introduction

Negative emotions and depression have been shown to influence dietary intake (Gibson, 2006). While the typical response to negative emotions and stress is to eat less, studies shows that eating more, as exhibited in atypical depression is also common (Gold & Chrousos, 2002). Previous evidence indicated that eating in response to stress and negative emotions associated with depression often consist of eating unhealthy and low quality food such as sweet snacks and fast-food (Oliver, Wardle, & Gibson, 2000). In the long run, unhealthy dietary intake contributes substantially to weight gain at the individual level, thereby increasing the burden of obesity at the population level (Schutz and Garrow, 2000). Therefore, unraveling which factors are associated with dietary intake is of major importance. Two important and interrelated factors associated with dietary intake are depression and eating styles, but their combined effects still remain uncertain.

Persons with higher depression severity are shown to have a less healthy dietary pattern including lower intakes of fruit, vegetables, whole grains, poultry, fish, and reduced-fat dairy products (Lai et al., 2014; Quirk et al., 2013). They also achieve lower Mediterranean Diet scores, which is another indication of poorer diet quality (Psaltopoulou et al., 2013). In addition, depression severity is associated with higher

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total energy intake from saturated fat and sugars (Whitaker, Sharpe, Wilcox, & Hutto, 2014) and higher sweet food consumption (Jeffery et al., 2009). Depression diagnosis has also been associated with reduced fruit, and vegetable intake (Payne, Steck, George, & Steffens, 2012). Eating to regulate emotions (emotional eating), eating in response to external cues (external eating) and cognitive eating control (restrained eating) have been suggested to be related to increased (for emotional and external eating) and decreased (for restrained eating) overall energy intake, carbohydrate and fat intake, energy dense and sweet foods, snack and fast-food intake (Adriaanse, de Ridder, & Evers, 2011; Anschutz, Van Strien, Van De Ven, & Engels, 2009; Brogan & Hevey, 2013; Camilleri et al., 2014; Conner, Fitter, & Fletcher, 1999; Connor, Jones, Conner, Mcmillan, & Ferguson, 2008; de Lauzon et al., 2004; Elfhag, Tholin, & Rasmussen, 2008; Jaakkola, Hakala, Isolauri, Poussa, & Laitinen, 2013a, 2013b; Konttinen, Männnistö, Sarlio-Lähteenkorva, Silventoinen, & Haukkala, 2010; Lluch, Herbeth, Méjean, & Siest, 2000; Newman, O'Connor, & Conner, 2007; Olea López & Johnson, 2016) in most, but not all (Brogan & Hevey, 2013; Conner et al., 1999; Connor et al., 2008; Jaakkola et al., 2013a, 2013b; Konttinen et al., 2010; Newman et al., 2007; Olea López & Johnson, 2016) studies. Especially for emotional and restrained eating, a consistent pattern does not always emerge.

While depression and eating styles have been suggested to be factors contributing to unhealthy dietary intake, they are also associated with each other. In a previous paper from our research group, we were the first to show that not only depression severity, but also current and remitted depressive disorders, were associated with more unhealthy emotional and external eating (Paans et al., 2018). While emotion regulation theories suggest that affect regulating strategies (such as emotional eating) can induce a change in emotional state (Gross et al., 2007), a recent meta-analysis showed that emotional eating does not lead to a change in affect (Haedt-Matt et al., 2014). Most studies provide evidence that higher levels of depression lead to less favorable levels of eating styles (Konttinen et al., 2010; Ouwens, van Strien, & van Leeuwe, 2009; van Strien, Konttinen, Homberg, Engels, & Winkens, 2016). Moreover, experimental studies also have shown that, in responses to negative emotions, emotional eaters consume more energy-dense foods (Oliver et al., 2000). Thus, although no longitudinal studies are available yet, most evidence points in the direction of depression causing unhealthy eating styles, and not the other way around.

To disentangle and compare the contributions of depression and eating styles on dietary intake, it would be advantageous to consider both of these factors in one study simultaneously. Studies analyzing depression, eating styles and dietary intake are rare. One study from Konttinen et al. found that both depressive symptoms and unhealthy emotional eating were associated with higher intake of energy dense sweet and non-sweet foods. However the association between depressive symptoms and intake of sweet foods became non-significant when adjusting for emotional eating (Konttinen et al., 2010), indicating a possible mediation effect of emotional eating. Results also showed an interaction effect between depression and emotional eating for non-sweet foods: those with low scores on both of the scales consumed lower amounts of these non-sweet foods. Camilleri et al. also found significant interactions between depression and emotional eating in association with dietary intake, and therefore stratified their analyses according to high versus low depressive symptoms (Camilleri et al., 2014). The key finding of this study was that among depressed women, but not men, emotional eating was associated with greater consumption of energy-dense snacks and higher total energy intake. While this preliminary evidence suggests both unhealthy eating styles and depression to influence dietary intake, much is still uncertain. Both studies failed to investigate external eating and restrained eating was only included as a covariate by Konttinen et al. (Konttinen et al., 2010), and ignored by Camilleri et al. (Camilleri et al., 2014). We previously showed depression to be associated to both emotional and external eating (Paans et al., 2018). As all three eating styles seem to be associated with dietary intake, studying all three eating styles should be considered when studying the interplay between depression, eating styles and dietary intake. Moreover, the Konttinen and Camilleri studies used non-clinical samples and depression severity scores were fairly low (Camilleri et al., 2014; Konttinen et al., 2010), while associations between depression, eating styles and dietary intake should also be investigated in persons who actually have a clinical diagnosis.

To date, it remains unknown whether the relationship between depression and dietary intake is (partially) explained by eating styles. In addition, it remains unknown whether – in line with moderation - the combination of depression and unhealthy eating styles more strongly determines dietary intake than the separate components. Therefore, the current study investigated the associations of, and interplay between depression and eating styles in relation to different aspects of dietary intake. Four aspects of dietary intake were analyzed: 1) total energy intake, 2) dietary quality, 3) sweet food consumption and 4) fast-food and savory snack consumption. Initially, the independent associations between depression and eating styles and all four dietary intake measurements were analyzed. We hypothesized depression, emotional and external eating to be associated with lower diet quality, higher total energy intake and higher intake of sweet foods and fast-food/savory snacks, while associations in opposite directions were expected for restrained eating. Second, we studied whether associations between depression and dietary intake were mediated by eating styles. We expected the associations between depression and lower dietary quality, higher total energy intake, and higher intake of sweet foods and fast-food/savory snacks to be mediated by higher emotional and external eating. Finally, we examined whether the associations between depression and dietary intake differed in persons with different levels of eating styles. We expected that associations between patients with depression and low dietary quality, higher total energy intake, and higher intake of sweet foods and fast-food/savory snacks are stronger in persons with higher levels of emotional and external eating.

2. Material and methods

2.1. Study sample

Data from the Netherlands Study of Depression and Anxiety (NESDA), an ongoing cohort study of persons with depressive and anxiety disorders and healthy controls were used. In order to represent diverse settings and developmental stages of psychopathology, 2981 adults (18–65 year) from the community (19%), general practice (54%) and specialized mental health care (27%) were included at baseline. Exclusion criteria were a primary clinically overt diagnosis of other psychiatric disorders such as psychotic disorder, obsessive-compulsive disorder, bipolar disorder, or severe substance abuse disorder, and insufficient command of the Dutch language. The research protocol was approved by the Ethical Committees of the contributing universities and all participants provided written informed consent. A detailed description of the NESDA study design can be found elsewhere (Penninx et al., 2008). Between September 2004 and February 2007, all participants underwent a baseline assessment containing an extended face-to-face interview conducted by a trained research assistant, which included a standardized diagnostic psychiatric interview (Composite International Diagnostic Interview (CIDI) version 2.1, (Wittchen, 1994)) and self-report questionnaires. This paper is based on data of the 9-year follow-up wave in which eating styles and dietary intake were measured. Data of earlier waves was used to create psychiatric status groups. Nine year follow-up data was available for 2069 participants. After excluding participants with pure anxiety disorders (n = 195), on whom data on psychiatric disorders was inconclusive due to too many missing follow-up data (n = 13), persons with missing data on the psychological eating styles (n = 111), the food frequency questionnaire (n = 277) or had improbable energy intake (females: < 500 kcal, > 3500 kcal and males: < 800 kcal, > 4000 kcal (Willett, 2013); n = 31),

the final study sample consisted of 1442 participants (328 controls, 880 participants with a remitted depressive disorder, and 234 with a current depressive disorder). Those with missing data at the 9-year follow up were significantly younger ($p < .001$), more often male ($p < .01$) lower educated ($p = .001$), and had more severe depressive symptoms ($p < .001$) compared to the sample included in this paper.

2.2. Depression measurements

During each assessment, presence of a DSM-IV depressive (MDD, dysthymia) or anxiety disorder was established using the CIDI (Wittchen, 1994). At the 9-year follow up, all participants were classified as 1) having no lifetime psychiatric disorder (controls), 2) having a remitted depressive disorder, or 3) having a current depressive disorder based on information from baseline to 9-year follow up. Persons in the remitted group had a lifetime history of depressive disorder but no diagnosis in the past 6 months as diagnosed with the CIDI, and current patients had CIDI-diagnosed depressive disorder (major depressive disorder, dysthymia) in the past 6 months.

At 9-year follow-up, severity of depressive symptoms in the past week was assessed with the 30-item Inventory of Depressive Symptomatology - Self Report (IDS-SR, range 0–84 (Rush, Gullion, Basco, Jarrett, & Trivedi, 1996);). Items were scored from 0 ('no problems') to 3 ('severe problems') and a sum score was computed and standardized.

2.3. Eating styles

At the 9-year follow up, the short version Dutch Eating Behavior Questionnaire (DEBQ) (van Strien, 2015; van Strien, Frijters, Bergers, & Defares, 1986) was used to assess emotional eating (6 items, e.g. "Do you have a desire to eat when you are irritated?"), external eating (7 items, e.g. "If food smells and looks good, do you eat more than usual?") and restrained eating (7 items, e.g. "Do you try to eat less at mealtimes than you would like to eat?"). Response categories range from 1 'never' to 5 'very often'. The full version DEBQ scales have high internal consistency, high validity for food consumption, and high convergent and discriminative validity (COTAN, 2013; van Strien, 2015). The current study showed, using exploratory factor analysis, that all items in this analysis had primary loadings over 0.57, with the mean factor loadings being 0.84 for the emotional eating scale, 0.79 for the external eating scale and 0.67 for the restrained eating scale. The non-target loadings (loadings in factors that the item was not intended to measure) had a mean value of 0.15, 0.09 and 0.14 for the emotional, external and restrained eating scales respectively, with an overall range from 0.01 to 0.30. Internal consistency for the three subscales was adequate (emotional eating $\alpha = 0.95$, external eating $\alpha = 0.82$, restrained eating $\alpha = 0.91$). The inter-correlation between emotional and external eating was found to be 0.52, 0.29 between emotional and restrained eating, and 0.17 between external and restrained eating. Eating scales scores were standardized for the main analyses.

2.4. Dietary intake

Dietary intake was assessed during the 9-year follow-up with a 238-item, semi-quantitative food frequency questionnaire (FFQ) which was based on a validated ethnic Dutch FFQ (Siebelink, Geelen, de Vries, & Vries, 2018). The FFQ asked about the frequency, amount and type of food eaten in the past month. Using the Dutch Food Composition Table 2014 (Centre NI for P.H. and the N.N.,2011), daily intakes (g/day) of the 238 food items were calculated. Using the FFQ, energy intake (kcal/day) could be calculated. Population medians were used for missing amounts. Likewise, missing product type (e.g. full-fat milk, semi-skimmed milk or skimmed milk) was replaced with distributions reflecting the population median. The total amount of missings was 0.58%. The FFQ also included the option to add additional food items consumed within the last week that were not included in the questionnaire. These items were manually re-categorized to comparable food items where possible. Each manual adjustment was made by consensus of two nutritional scientists.

Diet quality was measured with the Mediterranean diet score (MDS), which was is developed by Panagiotakos et al. (Panagiotakos, Pitsavos, & Stefanadis, 2006). The MDS includes 10 food components (non-refined grains, potatoes, fruits, vegetables, legumes, fish, red and processed meat, poultry, full fat dairy products, olive oil and alcohol). Components are scored from 0 to 5 based on weekly consumption according to their position in the Mediterranean diet pyramid (Oldways, 1993) with a total score range of 0–55. This MDS was chosen because it is an established score that has been shown to be associated with depression according to other diet-depression studies (Psaltopoulou et al., 2013) and has also been associated with lower mortality (Sofi, 2009) and other somatic diseases (Gotsis et al., 2015).

Intakes of sweet snacks, and intakes of fast-food/savory snacks were derived from the FFQ. Food items included in sweet snacks-group were (among others) sugar and honey, different kinds of sweet spreads, sweet deserts, ice-lollies, sweets, candy bars, chocolate, cookies and cakes. The fast-food and savory snack-group included pizza, French fries, fried snacks, potato chips, and salty biscuits.

2.5. Sociodemographic and lifestyle and health variables

Age, sex, years of education and marital status (single, married, divorced/separated/widowed) were assessed during interview. Lifestyle and health variables contained smoking (never, former, current), physical activity, and current body mass index (BMI). Physical activity during the past week was measured at the 9 year follow-up with the International Physical Activity Questionnaire (IPAQ) and expressed as 1000 MET minutes/week (Ekelund et al., 2006; Kurtze, Rangul, & Hustvedt, 2008). Height and body weight were measured by a trained research assistant. BMI was calculated as weight kilograms divided by height squared in meters (kg/m^2). All covariates were measured at 9-year follow-up.

2.6. Statistical analyses

First, 9-year follow-up sample characteristics were described as means and standard deviations, or percentages. All subsequent analyses were adjusted for age, gender, years of education, marital status, BMI, smoking and physical activity. All analyses with MDS, intake of sweet or fast-food as outcomes were also adjusted for energy intake (kcal/day), to take into account the different overall caloric intake that may be related to these dietary intake measures. Before starting the main analyses, it was examined whether there was an interaction effect of gender by adding interaction terms of gender*depression diagnosis or gender*eating styles for each of the four food groups, since stratification for gender was done in some earlier studies.

Separate linear regression analyses were used to estimate the relationship between 1.) severity of depressive symptoms (IDS), 2.) depression diagnosis (healthy controls, remitted patients, current patients) and all three eating styles eating styles (3.) emotional eating, 4.) external eating or 5.) restrained eating) with the four dietary intake variables (overall energy intake, MDS, sweet foods, fast-food/savory snacks). Hereafter, to examine whether the associations between depression and dietary intake appeared to be (partly) due to eating styles, analyses according to the Hayes statistical mediation model were performed (Hayes, 2012). We applied statistical mediation analyses to test I) the associations between depression and eating styles (pathway a in Fig. 1); II) the associations between the separate eating styles and dietary intake (pathway b in Fig. 1); III) the direct associations between depression and dietary intake, corrected for a x b (pathway c' in Fig. 1); and IV) the indirect associations between depression and dietary intake through the separate eating styles (pathway a x b). Analyses were

Table 1
Sample characteristics of the NESDA participants at the 9-year follow-up (N = 1442).

	Total group
Demographics	
Age (years, mean, sd)	51.7 (13.5)
Gender (%, female)	64.1
Education (years, mean, sd)	13.4 (3.4)
Marital status (%)	
Single	32.4
Married	50.4
Divorced/separated/widowed	17.2
Lifestyle	
BMI (kg/m^2,mean, sd)	26.4 (5.0)
Smoking (%)	
Never	41.1
Former	40.1
Current	18.3
Physical Activity (1000 MET mins/week (mean, sd)	3.6 (3.0)
Psychiatric characteristics	
Severity of depressive symptoms (mean, sd)	15.6 (14.3)
Depression diagnosis (%)	
Healthy controls	22.7
Remitted patients	61.0
Current patients	16.3
Psychological eating styles scores [a]	
Emotional eating (mean, sd)	2.3 (1.0)
External eating (mean, sd)	2.7 (0.6)
Restrained eating (mean, sd)	2.7 (0.9)
Food intake [b]	
Total energy intake (kcal, mean, sd)	2150.4 (582.7)
Mediterranean diet score (mean, sd)	32.6 (5.0)
Sweet foods (grams/day, mean, sd)	75.7 (52.8)
Snack/fast foods (gram/day, mean, sd)	43.0 (38.3)

IQR = inter quartile range.
[a] As measured with the Dutch Eating Behavior Questionnaire.
[b] As measured with a 238-item food frequency questionnaire.

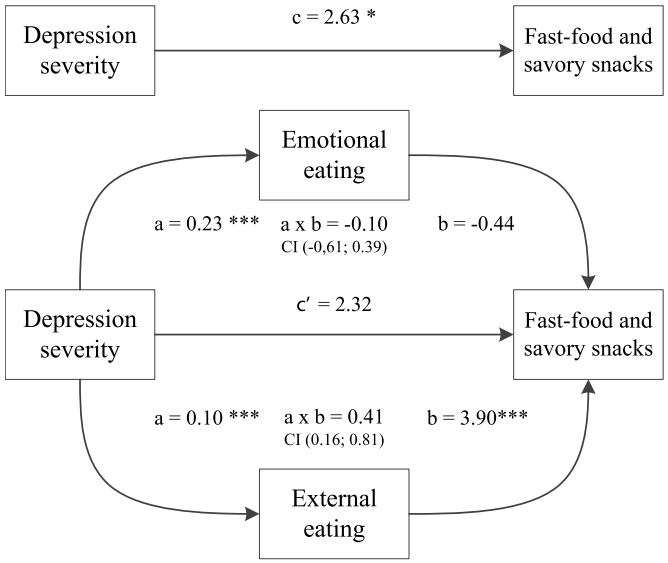

Fig. 1. Illustration of the total effect of depression on food intake (c) and a statistical mediation design where depression is associated with food intake directly (c') and indirectly (a x b) through eating styles. Statistical mediation analyses for standardized depression severity as independent variable and intake of fast-food and savory snacks as outcome variable via standardized emotional and external eating based on 5000 bootstrap resamples.
*p < .05, **p < .01, ***p < .001.

performed using the Hayes SPSS 'process' macro, which estimates the indirect associations of the independent variable on the dependent variable through the contributing variables (Hayes, 2012). This method uses bootstrap resampling procedures, in which participants are randomly selected, with replacement, from the original sample. For each bootstrap sample the model was estimated and the parameters saved. The indirect association was deemed significant if the 95% bootstrap percentile confidence interval did not include zero. Number of bootstraps were set at 5000. Eating styles found to be successfully contributing to the relationship between depression and one specific dietary intake variable at the previous analyses were entered into a final multiple mediation model.

Next, to study whether depression and eating styles augment each other, it was tested whether the interaction term between depressive diagnosis or depression severity * emotional eating, external eating or restrained eating was significantly associated with each dietary intake measure as outcome. The corresponding variables depression diagnosis or severity and eating styles were also included in these analyses. (Cohen, Cohen, West, & Aiken, 2003).

Analyses were conducted using SPSS version 22.0 (IBM Corp., Armonk, NY, USA). All analyses were corrected for multiple testing with use of the modified false discovery rate Benjamini and Yekutieli (FDR (B-Y)) method (Narum, 2006).

3. Results

3.1. Descriptives

The mean age of the 1442 participants was 51.7 (SD = 13.5) year, and over two-thirds was female (Table 1). More than half of the participants was married, and the mean BMI was 26.4 kg/m2 (SD = 5.0), 34.4% had overweight while 19.7% suffered from obesity. Almost half of the participants had never smoked. The mean depression severity score as measured with the IDS was 15.6 (SD = 14.3), and the current sample consisted of 22.7% healthy controls, 61.0% remitted patients and 16.3% current patients. The mean energy intake was 2150.4 kcals/day (SD = 582.7) and the mean MDS score was 32.6 (SD = 5.0). The average intake of sweet foods was 75.5 (SD = 52.8) grams per day, while they daily consumed on average 43.0 grams (SD = 38.3) of fast-food/savory snacks.

3.2. Associations between depression, eating styles and dietary intake

We found no significant modifying effects of gender on the relationship between depression and dietary intake, or eating styles and dietary intake for 23 of the 24 interactions tested (p-values between .08 and .92; critical p-value for multiple testing is 0.01390 (Narum, 2006)), indicating similar associations between depression/eating styles and dietary intake across males and females. As only one interaction out of the 24 gender interaction terms tested showed to be significant (gender * external eating in association with fast-food/savory snacks (p = .01)), which could simply reflect a chance finding, all subsequent analyses were not stratified by gender. To follow up on the interaction, a stratified analyses showed external eating to be associated to fast-food/savory snacks among both men and women, although the association was stronger in men.

Linear regression analyses showed that higher depression severity was significantly associated with lower MDS score (indicating a poorer diet quality), a higher intake of sweet foods, and a higher intake of fast-food/savory snacks (Table 2). Patients with a current depressive disorder also had significantly poorer diet quality, and a higher intake of fast-food/savory snacks compared to the healthy controls. No significant associations with total energy intake (for depression severity and diagnosis) or intake of sweet foods (for current depression diagnosis) were found. Also, no associations between remitted depression and dietary intake were found.

Results showed that both emotional eating and external eating were associated with higher intake of fast-food/savory snacks (Table 2) and external eating was associated with higher total energy intake.

Table 2
Associations of current depression diagnosis, standardized depression severity and standardized eating styles separately with total energy intake, Mediterranean diet score (MDS), intake of sweet foods or fast food and savory snacks (N = 1442).

	Total energy intake (1000 kcal/day)		Mediterranean diet score		Sweet foods		Fast-food and savory snacks	
	B	*p*-value	B	*p*-value	B	*p*-value	B	*p*-value
Depression diagnosis								
Healthy controls	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Remitted patients	0.03	.50	−0.43	.21	2.09	.51	2.67	.24
Current patients	0.06	.26	**−1.11**	**< .01**	8.02	.05	**9.71**	**< .001**
Depression severity	0.03	.04	**−0.63**	**< .001**	**3.51**	**< .01**	**2.78**	**< .01**
Emotional eating	0.04	.04	0.07	.64	1.91	.17	**2.51**	**< .01**
External eating	**0.09**	**< .001**	0.10	.48	−1.60	.25	**4.25**	**< .001**
Restrained eating	**−0.12**	**< .001**	**1.00**	**< .001**	**−4.58**	**< .01**	−1.38	.17

Multivariable linear regression analyses were done for depression diagnosis, depression severity and each eating style separately, adjusted for age, gender, years of education, marital status, smoking, physical activity and total energy intake (for MDS score, sweet foods and fast-food and savory snacks).
NB: variables in bold indicate significance, the critical p-value according to the modified false discovery rate Benjamini and Yekutieli (FDR (B-Y)) method for multiple testing was used (p = 0.01390).

Conversely, restrained eating was associated with lower total energy intake, with a higher MDS score, indicating a better diet quality, and with a lower intake of sweet foods.

3.3. Statistical mediation analyses

Table 3 shows the results of the statistical mediation analyses with depression severity as independent variable. Depression severity is significantly associated with emotional and external eating (a-paths). External eating is significantly associated with both total energy intake, and intake of fast-food/snacks (b-paths). The direct association between depression severity and total energy intake is shown to be non-significant (c'-path), but the indirect effect (mediation effect) of depression severity on total energy intake through external eating is shown to be significant (a x b-path). For intake of fast-food/snacks, the direct association between depression severity and fast-food/snacks became non-significant (c'-path) with the addition of emotional or external eating indicating that emotional and external eating styles are mediators between depression severity and fast-food/snacks (a x b-path).

For the association between depression severity and fast-food/snacks, a final multivariable mediation model was made including both emotional and external eating in the same model (Fig. 1). Results showed that external eating was the only mediator that remained significant, while emotional eating became non-significant.

Similar results were found when analyzing depression diagnosis, with external eating as mediator, although the direct association between depression and fast-food/snacks remained significant after addition of external eating as mediator (Supplementary Table 1). This indicates that external eating is only partly responsible for the association between depression diagnosis and fast-food/snacks. For emotional eating, no significant mediation was found.

3.4. Interaction between depression and eating styles

We studied whether the association between eating styles and dietary intake differed between depressed patients and healthy controls by testing the interaction terms between depression * eating styles and associating those terms with total energy intake, MDS, intake of sweet foods and intake of fast-food/savory snacks. The interaction tests indicated that the association between depression severity or depression diagnosis (healthy controls versus current patients) and intake of sweet foods differed by level of restrained eating (p = .02 for severity, and p = .01 for diagnosis). However, as the critical p-value for multiple testing for 24 tests is 0.01324 (Narum, 2006), only associations with

Table 3
Statistical mediation analyses for standardized depression severity as independent variable and total energy intake, Mediterranean diet score (MDS), intake of sweet foods or fast food and savory snacks as outcome variables via standardized eating styles based on 5000 bootstrap resamples (N = 1442).

Separate mediators	I. Association between depression severity and eating style (a)	II. Association between eating style and outcome(b)	III. Direct association between depression severity and outcome (c')	IV. Indirect association between depression severity and outcome (a x b)	
	B (SE)	B (SE)	B (SE)	B (SE)	95% CI
Total energy intake (1000 kcal/day)					
Emotional eating	**0.21 (0.03)*****	0.03 (0.02)	0.03 (0.02)	0.01 (0.004)	[-0.002; 0.01]
External eating	**0.10 (0.03)*****	**0.09 (0.02)*****	0.03 (0.02)	**0.01 (0.003)**	**[0.004; 0.02]**
Restrained eating	0.03 (0.03)	**−0.12 (0.02)*****	**0.04 (0.02)***	−0.003 (0.04)	[-0.01; 0.004]
Mediterranean diet score					
Emotional eating	**0.21 (0.03)*****	0.22 (0.14)	**−0.67 (0.15)*****	0.05 (0.03)	[-0.02; 0.11]
External eating	**0.10 (0.03)****	0.16 (0.15)	**−0.65 (0.15)*****	0.02 (0.02)	[-0.01; 0.06]
Restrained eating	0.04 (0.03)	**1.02 (0.15)*****	**−0.67 (0.15)*****	0.04 (0.03)	[-0.02; 0.11]
Sweet foods					
Emotional eating	**0.21 (0.03)*****	1.17 (1.51)	**3.27 (1.51)***	0.25 (0.32)	[-0.37; 0.91]
External eating	**0.10 (0.03)*****	1.92 (1.41)	**3.70 (1.48)***	−0.18 (0.16)	[-0.59; 0.06]
Restrained eating	0.04 (0.03)	**−4.72 (1.24)****	**3.70 (1.40)***	−0.18 (0.16)	[-0.59; 0.05]
Fast-food and savory snacks					
Emotional eating	**0.23 (0.03)*****	1.50 (1.00)	2.29 (1.22)	**0.34 (0.23)**	**[0.09; 0.82]**
External eating	**0.10 (0.03)*****	**3.70 (0.95)*****	2.24 (1.15)	**0.39 (0.14)**	**[0.16; 0.75]**
Restrained eating	0.05 (0.03)	−1.65 (0.89)	**2.71 (1.17)***	−0.08 (0.07)	[-0.33; 0.01]

Analyses are adjusted for age, gender, years of education, marital status, smoking, physical activity and total energy intake (for Mediterranean diet score, sweet foods and fast-food and savory snacks).
*p < .05, **p < .01, ***p < .001.

depression diagnosis*restrained eating remained significant. Results showed that within the healthy control group there was a significant association between more restrained eating and lower intake of sweet foods (B = −5.76, p = .03), whereas in the current patients, this association was non-significant (B = −1.30, p = .70).

4. Discussion

The current study investigated the independent and combined associations of depression and three eating styles with dietary intake, using a large cohort of participants with and without depressive disorders. Result showed that depression severity and current depression diagnosis were associated with unhealthy dietary intake and worse dietary quality, higher intake of sweet foods and fast-food/savory snacks and a lower Mediterranean diet score (MDS) respectively. Emotional and external eating were also shown to be associated with unhealthy food intake, while restrained eating was associated with a more favorable food intake and diet quality. The association between depression and intake of fast-food/savory snacks was mediated by external eating. No statistical mediation through emotional eating or restrained eating was found. Finally, the association between restrained eating and sweet foods differed between healthy controls and current patients. No other interactions between depression and eating styles for dietary intake were found.

Our results confirm previous evidence that showed associations between depression and a lower Mediterranean diet score (Molendijk, Molero, Ortuño Sánchez-Pedreño, Van der Does, & Angel Martínez-González, 2018; Psaltopoulou et al., 2013), higher intake of sweet foods (El Ansari, Adetunji, & Oskrochi, 2014; Jeffery et al., 2009; Westover & Marangell, 2002) and higher intake of fast-food and savory snacks (El Ansari et al., 2014; Whitaker et al., 2014). Our results are also in accordance with previous evidence examining associations between emotional and external eating and unhealthy dietary intake (Brogan & Hevey, 2013; Conner et al., 1999; Connor et al., 2008; de Lauzon et al., 2004; Jaakkola et al., 2013a, 2013b; Konttinen et al., 2010; Newman et al., 2007), although we failed to find specific associations with intake of sweet foods. Results of the current study showed restrained eating to be associated with less unhealthy dietary intake and better diet quality, which is in accordance with most previous studies (Adriaanse et al., 2011; Anschutz et al., 2009; Brogan & Hevey, 2013; de Lauzon et al., 2004; Elfhag et al., 2008; Jaakkola et al., 2013a, 2013b; Lluch et al., 2000; Olea López & Johnson, 2016). There are however also some studies that failed to find associations between restrained eating and dietary intake (Conner et al., 1999; Jaakkola et al., 2013a, 2013b; Konttinen et al., 2010; Olea López & Johnson, 2016), or even report associations between high restrained eating and higher snack intake (Connor et al., 2008; Newman et al., 2007). Recent reviews concluded that restrained eating cannot be classified as entirely healthy or unhealthy (Johnson, Pratt, & Wardle, 2012; Schaumberg, Anderson, Anderson, Reilly, & Gorrell, 2016), but rather could be health promoting or detrimental depending on the circumstances under which it is employed. For example, in normal weight persons restrained eating could be a marker for overeating. In contrast, in obese subgroups restrained eating could be an indication of persons who try to attempt to control their eating. In addition, whether restrained eating can be considered as healthy or unhealthy, also depends on whether the questionnaire used measures successful or unsuccessful dieting. The DEBQ used in the current study measures successful, healthy restrained eating (van Strien, Peter Herman, Engels, Larsen, & van Leeuwe, 2007).

The current study is the first to compare and combine associations of depression and external and restrained eating with dietary intake, while two earlier population studies already investigated depression in combination with emotional eating. The current study hypothesized that associations between depression and dietary intake are partly due to eating styles. In accordance with the study by Konttinen et al. (Konttinen et al., 2010), the current study found depression to be associated with intake of fast-food/snacks independent of emotional eating. However, while the current study also found depression to be independently associated with intake of sweet foods, this was not the case for the Konttinen study. Konttinen et al. therefore suggested emotional eating to be a mediating mechanism through which depression is related to intake of sweet foods. This could not be confirmed in the current study, where we did not find any evidence for mediation by emotional or restrained eating. As depression is a heterogeneous entity with subtypes characterized by decreased appetite (melancholic depression) and increased appetite (atypical depression) (Lamers et al., 2010; Milaneschi et al., 2015), it could be that mediation of associations between depression and dietary intake by eating styles are more often found when analyzed by subtype. However, a recent study by Gibson-Smith et al. using the same cohort did not find any patterns among depressive symptoms related to melancholic or atypical depression and dietary intake (Gibson-Smith et al., 2000). Therefore we decided to ignore the depressive symptom profiles. The current study showed external eating to be a significant mediator in associations with total energy intake, and intake of fast-food/savory snacks. As mediation of eating styles on associations between depression and dietary intake has never been examined before, results cannot be compared with earlier research.

Results of the current study showed an interaction effect between depression diagnosis and restrained eating in relation to intake of sweet foods. Results showed that there was a significant association between restrained eating and lower intake of sweet foods in the healthy control group, whereas in the patients with a current diagnosis no significant association was found. No other interactions between depression and eating styles were found. This suggest that depression and eating styles do not augment each other in associations with dietary intake. These interaction results are not in accordance with previous studies. A study by Camilleri et al. found significant interaction between depressive symptoms and emotional eating for total energy intake and 3 groups of sweet foods (cakes/biscuits/pastries, chocolate, artificially sweetened soft drinks) (Camilleri et al., 2014). They reported that associations between emotional eating and sweet-and-fatty snacks were more pronounced in women with depressive symptoms compared with those without depressive symptoms, however, this was not the case for men. Another study by Konttinen et al. found a significant interaction between depressive symptoms and emotional eating for fast-food/savory snacks (Konttinen et al., 2010). They reported that only those with both low depressive symptoms and low emotional eating had a lower intake of fast-food/savory snacks, and did not find anything for persons with both high depressive symptoms and high emotional eating. The current and two previous studies differ in study sample with respect to severity of depressive symptoms, and the current study is the first to also include external and restrained eating. Thereby, more research is needed before firm conclusions on possible interactions of depression and eating styles on dietary intake can be drawn.

The current study has some important strengths. It presents novel findings showing associations between both depression severity, depression diagnosis, and three eating styles with dietary intake. Also, we included a large, generalizable group of participants, recruited from community, general practice and specialized mental health care. Another strength is that the current FFQ included serving sizes, thereby making the estimation of habitual dietary intake more accurate. However, this study also suffered from some limitations. The most important limitation is the use of cross-sectional data, preventing inference of causality. Another limitation is the use of self-report data, which poses the risk of underreporting due to social desirability or unawareness of one's behavior. It is known that people have a tendency to underreport unhealthy eating styles (Asbeck et al., 2002; van Strien, 1995), also over- and underestimation of actual food consumption, poor recall and the omission of frequently eaten items from the FFQ are inherent problems (Maurer et al., 2006). However, we removed participants with extreme energy intakes, and added other self-reported,

frequently consumed products which partially resolved these issues. Finally, it cannot be ruled out that reporting accuracy in the FFQ is influenced by depression severity and eating styles.

In conclusion, the current study found depression and unhealthy eating styles to contribute independently to a poorer dietary quality and higher intake of sweet foods and fast-food/savory snacks. An indirect association between depression and total energy intake through external eating was found. The association between depression and higher intake of snack/fast-food was explained by external eating, while yet unknown factors may be relevant for associations between depression, MDS and intake of sweet foods. Treatment programs for depression should be aware of both eating styles and unhealthy dietary intake patterns, and their connections. Given the current findings, treatment programs for diet among depressed patients should take into account that external eating cues may be an important mechanism linking depression and obesity. Thus, addressing external eating tendencies through such treatments as mindfulness, acceptance and commitment therapy, or behavioral therapy (Alberts, Thewissen, & Raes, 2012; Brewer et al., 2018; Daubenmier et al., 2011; Teixeira et al., 2010) could help address poor dietary habits. Prospective studies are needed to identify causal links and investigate possible mechanisms underlying the associations among depression, eating styles and dietary intake.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2018.12.030.

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